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ABSTRACT

An instrument was developed to measure students' engagement in various classes of study activities within multiple study contexts. This instrument is to be used in a large, ongoing research project investigating the underpinnings of student study activities and effects on academic achievement. The computer-administered instrument used--the Study Activity Questionnaire (SAQ)--is based on hierarchical models of the cognitive processing and effort management activities involved in academic study. Item types associated with different levels and dimensions of cognitive and effort management hierarchies for routine study and test preparation study were constructed. The SAQ was administered, using a microcomputer, to 235 students enrolled in 14 general biology courses at 7 high schools in the San Francisco Bay area. Results provide insights into the amount of time students engaged in study, allocation of study time, types of activities performed, and focus of cognitive activities. Data concerning students' engagement in the hierarchical study activities are encouraging. The patterns of responses reported for the routine context and the test preparation context were similar. However, the small differences that were found may be important to the extent that students change the character of their study practices in response to specific contextual factors, goals, purposes, or demands. It appears that the design of the SAQ and the microcomputer administration procedure have a great deal of potential for assessment and diagnostics. Fifteen data tables, one figure, and four samples of computer screen text are provided. (TJH)

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Using hierarchical models of studying to evaluate the character of students' study activities.

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Using hierarchical models of studying to evaluate the character of student's study activities.

The present study is part of a larger, on-going, research project investigating the underpinnings of students' study activities and the relationship between these study activities and academic achievement (Thomas & Rohwer, 1987). Our over-riding goal is to delineate the processes underlying the development of students' self-directed learning activities and the conditions necessary to prompt and support proficiency in studying.

This paper presents some preliminary results from an instrument we have developed to measure students' engagement in various classes of study activities. The instrument, called the Study Activity Questionnaire (SAQ), is based on hierarchical models of the cognitive processing and effort management activities involved in academic studying.

Framework

As a starting point, we view study ability, and the conditions surrounding the manifestation of that ability, in developmental terms. This perspective allows us to see how the construct of study ability emerges, that is, how it becomes more evident and differentiated as an individual develops and gains experience. This process is presumed to be affected by the interaction of the student's capabilities and dispositions, on the one hand, and the nature of his/her learning experiences, on the other (Brown, Bransford, Ferrara, and Campione, 1983).

We view the construct of self-directed learning ability as developing and progressing through several, cumulatively-ordered levels. We propose two hierarchical models: Cognitive and Effort Management. These models emphasize the cumulative nature of study ability.

The cognitive hierarchy presents four levels of study-skill development: Basic Encoding Activities, Selection Activities, Integration Activities and Extension Activities. The activities are ordered in terms of the cognitive complexity required to successfully perform them. A cumulative pattern of development is proposed. That is, each higher level activity emerges as an individual's competence at each lower activity level is attained. A detailed description of these models has been given in

Thomas, Rohwer, and Wilson (1989). The proposed cognitive hierarchy, which is the focus of this paper, is displayed in Figure 1.

Insert Figure 1

The hierarchical levels are ordered in two senses. First, each of the higher level activities presupposes and "operates" on the products produced by each of the lower-level activities. For example, in the cognitive hierarchy, a student must encode information (Basic Encoding) before he/she can select some portion of it for further study (Selection). Moreover, the nature of that selection depends on the nature of the encoded products.

Second, the activity levels are hierarchically ordered in the sense that each higher level activity is cognitively more complex than each of the lower level activities. Activities which are less complex and less generative in nature are located at the bottom levels of the hierarchy (e.g., Basic Encoding Activities) and the more complex, more generative activities are located at the top levels (e.g., Extension Activities). Thus, a more developed study-ability is presumed to be required to successfully engage in higher-level activities.

It has been shown for example, that older and more expert students are more likely than younger or less expert students to engage in Basic Encoding activities that involve comprehension enhancement, (e.g., Franks, Vye, Auble, Mezynski, Perfetto, Bransford, Stein, & Littlefield, 1982). Similarly, it has been shown that expert and more able studiers are more capable at engaging in selective allocation activities, such as identifying important, difficult, or criterion-relevant parts of text material (e.g., Brown & Smiley 1978; Meyer 1984). In addition, it has been shown that more able studiers compared to less able studiers integrate information more extensively (e.g., Bransford, Stein, Shelton, & Owings, 1981). And finally, it has been shown that more able studiers compared to less able studiers are more capable at extending information to new or different subject matter areas (e.g., Meyer, 1987).

The above evidence suggests that a developmental progression occurs. However, the evidence is lacking for an over-riding framework in which to view continuity or discontinuity in study-skill development. Thus, there is a need for a comprehensive study which investigates the hierarchical nature of study-ability development.

One of the goals of the present study is to identify a range of study activities which serve to define the domain of academic studying. Identifying this range of activities is necessary in order to systematically investigate how and why individuals vary in their proficiency at studying. The levels of study activities specified in the hierarchical model represent prototypical classes of study activities across the range of the domain. These classes of study activities vary on a difficulty continuum, with each higher-level activity increasing in cognitive processing complexity or knowledge base requirements for successful performance. In this way, the model attempts to define the domain of academic studying.

In addition to the major study activity levels just described, the model also proposes several other components or dimensions which affect proficiency in studying. In the cognitive hierarchy, three dimensions are proposed. Each of these dimensions are represented within each of the principal activity levels. The Initiative dimension, refers to the *source* of the decision to engage in the principal study activity. Students' decision to engage in a study activity may be self-initiated (i.e., Proactive), an opportunistic response to cues (i.e., Reactive), or a response to external requirements (i.e., Receptive).

The second dimension presented in the model refers to the type of knowledge product students focus on while studying. For example, students' selective processing activities may focus on low-level information products (facts, and details), middle-level information products (terms and definitions), or high-level information products (principles and generalizations).

The third dimension presented in the model (called Memory Augmentation) refers to the nature of the cognitive operation used to make information more memorable. This dimension ranges from the use of little or no memory operations, to the use of generative and constructive memory operations.

Method

Instrument Development

The Study Activity Questionnaire (SAQ) was designed to assess students' study-activity engagement across the range of activities specified in the Cognitive and Effort Management hierarchies. The SAQ was designed to elicit from students information regarding their engagement in the specific activities within multiple study "contexts". Item types associated with different levels and dimensions of the hierarchies were constructed for (1) routine studying (doing reading assignments, reviewing on a

routine basis) and (2) test preparation (in-class test review and autonomous test reviewing). The SAQ was designed to accommodate the possibility that students engage in a variety of activities to accomplish a given purpose and carry out these activities at various times and in various contexts. For example, students may seek to improve their memory for course material through rehearsal, notetaking or the construction of mnemonics. Further, students may attempt to improve their memory for course material at different times and in different ways, e.g., while reviewing the assignment on their own versus during a teacher-led review session.

Procedure

Administration of the SAQ

The SAQ is administered on a microcomputer. The computer version of the SAQ presents a sequence of items "tailored" to each student. A complex branching and stopping design is used to ensure that students answer follow-up questions only when it is appropriate to do so. That is, if the student answers positively to performing a study activity then he/she is given a series of follow-up questions regarding that particular activity level. Using this "tailored testing" design serves to increase the probability that each student is measured more precisely in the range of their ability.

Figure 2 presents an example sequence from the "Test Preparation / Autonomous Reviewing" context. Students are asked first if they engaged in a particular study context (studying for the test outside of class). If they answer "No," they exit to a different context. If they answer "Yes," they are presented with Screen #1. In Screen, #1 the student is asked to rate the first activity statement, which is highlighted in bold print with an arrow (i.e., Basic Encoding activity level) using the scale at the bottom of the screen. As the student rates each activity-statement, that statement becomes de-selected and the next activity statement becomes highlighted (see "Selection", Screen #2). This procedure continues until all activity statements on the screen have been rated. After a student rates each of the activity statements, he is given a series of follow-up questions specific to those activities levels which were positively rated. For example, following the sequence in Figure 2, if the student indicated that he engaged in Selection activities then he/she was given an Initiative follow-up (Screen #3) and a Knowledge Product follow-up probe (Screen #4). If the student did not indicate that he/she engaged in Selection activities, then no follow-up question for Selection would be presented. The computer keeps track of all of the student's responses and applies the branching and stopping rule for each response.

Insert Figure 2

Sample

The SAQ was administered to 235 students enrolled in 14 General Biology courses at seven high schools around the greater San Francisco Bay Area. The schools and courses were selected to yield a diversity of student populations, yet comparable subject-matter coverage and testing practices. Detailed curricular information was also gathered on each of these courses. Students were administered the SAQ individually on a micro-computer during their regular biology-course time period. The students were asked to answer each question on the SAQ with reference to how they studied for their biology class.

RESULTS

The results section will provide a descriptive analysis of students' reported study engagement, that is, the kinds of things students do while studying and learning academic material. The data will be presented in two main sections. The first section will describe students' study activities while reading the assigned reading for the first time --"Routine Study" context. The second section will describe students' study activities while preparing for the test outside of class --"Autonomous Reviewing / Test Preparation" context.

I. Routine Study Activities

The data presented in this section represents students' self-reports regarding their routine study activities, e.g., when they read the assignment for the first time.

A) Amount of time engaged in studying.

1. Total time studying. Students were asked to indicate how many days a week and how many hours per day (in 1/2 hr units) they typically spent studying for their biology course outside of class. The results are presented in Table 1. The top part of Table 1 displays the number of *days per week* typically engaged in studying. The results show that 32% of the students spent 3 days per week studying biology, twenty percent (20%) spent 4 days per week, 16% spent 5 days per week, and 12% spent 2 days per week. Only a very small proportion of the students indicated that they never studied on a routine basis (i.e., 1% of the students indicated that

they never studied). Overall the students spent an average (i.e., mode) of 3 days per week studying for their biology course (SD = 1.25 days per week).

Insert Table 1.

The bottom part of Table 1 presents the number of *hours per day* the students spent studying biology outside of class. The results show that 31% of the students indicated that they spent at least 1/2 hour per day, 32% spent 1 hour per day, 18% spent 1.5 hours per day, 6% spent 2 hours per day, 5% spent 2.5 hours per day and 1 % spent 4 hours per day studying biology. The mode for the sample is 1 hour per day.

It should be noted that (a) "studying" means all outside-of-class activity associated with the course, including doing homework exercises, and (b) students who indicated they studied for 1/2 hour per day may study for less than 1/2 hour.

2. Allocation of total study time. After indicating the total amount of time spent studying per week (i.e., the number of days per week and the number of hours per day), students were asked to divide their total time per week into the 6 activities listed in the left column of Table 2.

Insert Table 2

The 6 activities are listed in order of the proportion of students who engaged in the activity. The majority of students, 86% allocated their time to "Doing homework" exercises. In addition, these students indicated that they studied the homework assignment an average of 40 minutes per week. A little less than half of the sample, 46%, indicated that they allocated their study time to "Reading" the assignment. These students averaged approximately 33 minutes a week on this activity. Twenty-six percent (26%) of the sample indicated that they allocated their time toward the "Preparation of study materials (e.g., notes, outlines, charts)," for an average of 34 minutes a week. Eighteen percent (18%) indicated that they "Reviewed the textbook or study materials they developed" (an average of 34 minutes a week average for these students). Only a relatively small percentage of students indicated that they allocated their time in activities 5 and 6, "Reviewing teacher made handouts" (12%) and "self-testing" (10%). Students indicated that they spent an average of 30 minutes a week on each of these activities.

Another way to view the data is to calculate the total amount of time the students spent studying and the percent of that total time allocated to

studying in each category. The last two columns in Table 2 give these percentages. As can be seen, students allocated approximately 50% of their total time studying per week toward "Homework" exercises. In contrast, the other categories each account for less than 20% of students' study time. "Reading" accounts for only 18% of the total study time, "Preparing study materials, (notes, outlines, charts)" accounts for 13% of the total time, "Reviewing the text or study materials developed by the student" accounts for only 9% of the total time, "Reviewing teacher made handouts" accounts for 5% of the total time, and engaging in "self-testing" accounts for 4% of the total time.

B) Information Processing Activities

The next two sub-sections discuss the kinds of information processing activities students engage in while studying on a routine basis. First we look at the *kinds of activities* students engage in while reading the assignment for the first time. Next we look at the *focus* of students' cognitive efforts.

1) Kinds of activities preformed while reading the assignment.

Eighty-seven percent (87%) of the students in this sample indicated that they read or skimmed the assigned reading as part of their routine studying. The kinds of activities used while routinely reading and the proportion of students using these activities are presented in Table 3. The results show that a little over half of the students (51%) reported that they "Just read", 32% "Skimmed before reading", 30% "Took notes while reading", 13% "Highlighted information while reading", and 5% "Skimmed instead of reading".

Table 3.

2) Focus of cognitive activities.

The focus of students' cognitive activities will be discussed with reference to four aspects of the hierarchical model (presented in Figure 1). First, data regarding the frequency with which students engage in the various study activity levels will be presented. Second, data regarding the nature of the initiative to engage in each of the activity levels will be presented. Third, data regarding the kind of knowledge product students tend to focus on while studying will be presented. And finally, data regarding the kind of memory augmentation operations students engage in while studying will be presented.

Engagement in the hierarchical levels Students were asked to rate, how accurately each of the hierarchical study activities (i.e., Basic Encoding,

Selection, Integration and Extension) described what they did while reading the assigned reading (i.e. routine studying). The proportion of student responses to each of the activity levels is presented in Table 4 and Figure 3.

Students' pattern of responses regarding the strength of agreement to the four levels of study activities confirms the pattern of responses expected from the hierarchical model. That is, students agree more strongly to performing lower-level activities than higher-level activities, and conversely, they disagree more strongly to performing the higher-level activities than to the lower-level activities.

Insert Table 4, Figure 3

Table 4 and Figure 3 show that for Encoding activities, 21% of the students endorsed the strongest positive alternative "Very much like me". In addition, a little over half (54%) indicated a positive agreement "Like me," 24% indicated a marginal agreement "Somewhat like me", and 1% stated that Encoding activities were "Not at all like me".

The response pattern at the Selection level is similar to the response pattern at the Encoding level, however, two notable changes occur. Whereas the proportion of "Very much like me" responses is the same at both the Selection and Encoding levels (21% and 21%), there is a decrease in the proportion of students who endorse the "Like me" category at the Selection level (from 54% at Encoding to 46% at Selection). In addition, there is an increase in the proportion of students who endorse the "marginal" category "Somewhat like me" at the Selection level (24% at Encoding to 30% at Selection). The changes are in the expected direction. In general however, almost all of the students (99% to 97%) report engaging in Encoding and Selection activities at least somewhat while reading for the first time.

The pattern of response at the Integration level is quite different than the two lower hierarchical levels just described. At this level only 8% of the students endorsed the strongest positive response alternative "Very much like me" and less than a quarter (23%) of the students endorsed the "Like me" response alternative. In addition, the majority of students (52%) endorsed the marginal category "Somewhat like me", and 18% of the students reported that Integration activities are "Not at all like me". Thus, at the Integration level, a dramatic change occurs in the pattern of students' responses. Specifically, there is a shift away from engaging in

Integration activities compared to the level of engagement in Selection and Encoding activities.

The pattern of responses just described for the Integration level appears to increase in intensity at the Extension level. At this level 32% of the students indicated that they did not engage in "applying the material to things outside the course". In addition, 42% endorsed the marginal category "Somewhat like me". Furthermore, only 16% indicated the "Like me" alternative, and 10% indicated the "Very much like me" alternative.

Another way to view the dramatic shift in response patterns across the hierarchical levels is to compare the two more positive response alternatives ("Very much like me" and "Like me") to the two more negative response alternatives ("Somewhat like me" and "Not at all like me"). Table 5 presents this data.

Insert Table 5

Table 5 shows that at the two lowest levels of the hierarchy (Encoding and Selection), the majority of students report a rather strong endorsement of using these activities during first time reading. In contrast, at the two higher hierarchical levels (Integration and Extension), the majority of students report either no use, or little use of, these higher level activities during first time reading.

Initiative To Engage in Cognitive Processing Activities The next set of questions given to the students had to do with the source of their initiative to engage in the various study activities. For example, the students who indicated that they engaged in Selection activities were asked, "What prompted you to concentrate on finding the important information?" Students who indicated that they engaged in Integration activities were asked, "What prompted you to relate ideas to other ideas in the reading?" Students who indicated that they engaged in Extension activities were asked, "What prompted you to focus on applying the material to things outside the course?"

The response alternatives provided to the Initiative question (as shown in Table 6) were constructed to define a graded-response continuum from less self-initiated kinds of prompts (for example, "Features of the text") to more self-initiated kinds of prompts (for example, "I used my own judgment in deciding to find important material"). The results are presented in Table 6.

Looking first at the Selection initiative responses at the top of Table 6, it can be seen that two response alternatives were endorsed most frequently: 1) "Features of the material (e.g., bold headings titles, etc.)"; 63% agreed, and 2) "I used my own judgment in deciding to find important material"; 59% agreed. The other three alternatives by comparison received very few endorsements (e.g., 16% endorsed: "Teacher told us that we should concentrate on finding the important material," 12% endorsed: "Teacher hinted that we should concentrate on finding the important material," and 12% endorsed: "I could tell from the text we should concentrate on finding the important material."). According to the data then, students report that they are prompted to engage in Selection activities primarily because text features cue them or because they "use their own judgment."

Insert Table 6

The pattern of responses for students given the Integration follow-up is presented in the middle part of Table 6. As can be seen, the most frequently chosen alternative (65% endorsement) was, "I used my own judgment in deciding to relate ideas to other ideas in the reading." This is the self-initiated alternative. The next most frequently chosen alternative was "The text or other material stated that I should relate information," (28% agreement). Alternatives #3 and #4, received very few endorsements (13% and 15% agreement).

The pattern of responses observed for the Integration prompt is somewhat different from the pattern reported for the Selection prompt in at least two ways. First, the proportion of students agreeing to the alternative "used my own judgment" is higher for Integration activities (65% for self-initiative) than for Selection activities (59% for self-initiative). Second, the proportion of students agreeing to specific feature and text prompts is considerably less for Integration activities (28% for alternative #1) than for Selection activities (63% for alternative #1). Thus, at the Integration level, students report using their own initiative a little more frequently than at the Selection level.

The pattern of response for students given the Extension initiative follow-up is presented in the lower part of Table 6. As can be seen, the pattern of response for Extension initiative is very similar to the pattern just discussed for Integration initiative. More specifically, the most frequently endorsed alternative is, "I used my own judgment in deciding to apply the material to things outside the class" (74% agreed). The second most frequently endorsed alternative is, "The test, handouts, study guide,

stated that applying the material to things outside the course was important" (25% agreed). Finally, the third most frequently agreed to prompt is the alternative, "The teacher hinted that we should apply the material to things outside the course" (18% agreed).

In general, two aspects of these data are noteworthy. First, the pattern of responses just described indicate that students rather frequently use their own judgment (i.e., Proactive initiative) in deciding to engage in each of the study activities, Selection, Integration, and Extension. However, the trend across activity levels shows that the frequency of endorsement to this Proactive alternative is greatest for Extension level activities and least for Selection. Second, the results shows that for Selection activities, students are prompted most frequently by specific features and cues presented in text material, handouts, etc. In contrast, for Integration and Extension activities, such specific cue and feature prompts are less influential in prompting students to engage in these activities. The pattern appears to suggest that the initiative for engaging in study activities becomes more self-initiated and less externally prompted as one moves up the hierarchical levels.

Knowledge product. Type of information focused on while studying. The third dimension of the hierarchical model involves the type of information students concentrate on while studying. For example, students may focus on lower-level propositions (e.g., details and facts), mid-level propositions (e.g., definitions and terms), or high-level propositions (e.g., main ideas and principles).

The students who reported engaging in Encoding activities were given the follow-up question, "When you read to get the basic meaning of the material, what kind of information did you concentrate on?". The proportion of responses are presented in the top of Table 7. As can be seen from the top of Table 7, students focus on the "Meanings of words and concepts" (64%) and the "Meaning of sentence and paragraphs" (70%). In contrast, only 7% endorsed the first alternative, "How words are pronounced".

Insert Table 7

The middle portion of Table 7 presents the results of students who indicated that they engaged in Selection activities while reading the assignment. As can be seen, students indicated that they most frequently focused on "Main ideas and principles" (75%). In addition, students agreed

somewhat less to the first two alternatives, "Details and facts" 59% and "Definition and terms" 52%.

The lower portion of Table 7 presents the results of students who indicated that they engaged in Integration activities while reading for the first time. As can be seen, students reported that they most frequently concentrated on "Main ideas and principles" (78%). In addition, "Details and facts" were agreed to by 53% of the students, and "Definition and terms" were agreed to by 41% of the students.

Memory Augmentation Students were also asked to indicate if they did anything special to help them remember the material. Fifty-eight percent of the students responded that they tried to do something special to make the material more memorable. These students were then asked to indicate *what kinds* of things they did while reading to help them remember. The results from these students are shown in the top half of Table 8. As can be seen, 52% of the students indicated that they "Concentrated on remembering the important material," 49% stated that they "Concentrated on remembering the basic meaning of the material," 33% indicated that they "Concentrated on remembering the relationships between ideas in the material," and 18% indicated that they "Concentrated on remembering how the information applies to things outside the course."

Insert Table 8.

These same students were also asked another follow-up question regarding *how* they tried to remember the information. The results are presented in the lower half of Table 8. As can be seen, 66% of the students indicated that they tried to remember the information by "Putting the information in my own words." In addition, 31% indicated that they "repeated the material word-for-word," 22% "made up a chart/graph or diagram," and 17% "made up a story/rhyme or image."

II. Autonomous Reviewing / Test Preparation Activities

The following set of data represents students' self-reports regarding their study activities as they prepare for a test in biology.

A) Amount of time in preparation for the test.

1) Total time preparing for test Students were asked to estimate the total amount of time (in 1/2 hour units) they spent studying for the test

outside of class in the week immediately prior to the test day. Table 9 presents the break-down of hours and the percent of student responses. As can be seen, 13% of the students indicated that they did not spend any additional out-of-class time studying for the test. Of the remaining students who did study for the test, 11% indicated that they spent .5 hrs per week, 13% indicated 1 hour, 15% indicated 1.5 hrs, and 10% indicated 2 hrs of test preparation in the week prior to the test. There is a large decrease in responses above 2 hours. Overall, the most frequently indicated number of hours (i.e., the mode) was 1.5 hours per week.

Insert Table 9

Table 10 presents the data regarding how students divided their total study time into the 6 activities listed on the left side of the table. The majority of students, (61% and 60%) indicated that they allocated their time to one of two activities, "Doing homework" exercises and "Reading" in preparation for the test. These students indicated that they allocated an average of 56 minutes per week to "Doing homework" and 51 minutes per week to "Reading".

Insert Table 10

In addition, 45% of the students indicated that they prepared for the test by "Preparing study materials (e.g., notes, outlines, and charts)." The average time per week for this activity was 56 minutes. Forty-seven percent (47%) of the students indicated that they prepared for the test by "Reviewing teacher made handouts" or by "Reviewing the text book and study materials they developed." Students who performed these study activities averaged approximately 42-48 minutes per week respectively. Finally, 30% of the students engaged in "self-testing" kinds of activities in preparation for the test. Students engaging in these activities averaged approximately 45 minutes per week.

The two columns on the right side of Table 10 give the total number of hours per week the students engaged in each activity and the corresponding percent of time devoted to these activities. As can be seen, 23% of the students' total study time was allocated to "Doing homework", 21% to "Reading", 17% to "Preparing study materials (notes, outlines, charts)", 13% to "Reviewing teacher made handouts", 16% to "Reviewing the text book or study material they made", and 10% to "self-testing".

Several observations can be made regarding these data (Table 10) as they compare to the Routine study time data in Table 2. First, the

percentage of students who indicated that they allocated time to Test Preparation activities is less than the percentage of students who indicated that they allocated time to Routine studying. However, the total number of hours engaged in studying is much higher for Test Preparation than for Routine studying. For Test Preparation activities, the mean amount of time spent studying across the 6 activities ranged from 45 minutes to 56 minutes. However, for Routine studying the range was 30 minutes to 40 minutes. Second, the allocation of time to each of the 6 activities is more evenly distributed for students in Test Preparation than in Routine studying. For example, students reported that they allocated 50% of their total time during Routine studying to "Doing homework." In contrast, during Test Preparation, students' total study time was distributed more equally across the 6 activities.

B) Information Processing Activities

The next set of questions have to do with the *kinds* and *focus* of information processing activities students engage in in preparation for a test in biology.

1) Kinds of activities performed while preparing for the test

Students who reported that they actually studied for the test were asked to indicate what kinds of material they used to help them study. The top of Table 11 gives the percent of students who reported making various kinds of material to help them study. As can be seen, the large majority of the sample (78%) indicated that they made "Study notes." A little less than half of the sample, (45%), reported that they used "Lists of information," 32% made "Possible test questions," 20% made "Outlines," 16% made "Summaries," 13% made "Diagrams or Tables," 7% made "Flashcards," and 10% did not make any material.

Insert Table 11

The bottom of Table 11 presents the percentage of students who reported that they used various kinds of material to review for the test. Seventy-one (71%) percent of the students indicated that they used "Reading and lecture notes," 63% indicated that they used "The text or other reading assignments" and "Homework or lab exercises," 47% indicated that they used "Study guides or test preparation handouts," and 23% indicated that they used "Study materials that they developed."

2) Focus of cognitive activities

The focus of students' cognitive activities will again be discussed with reference to four aspects of the hierarchical model (presented in Figure 1). First, data regarding the frequency with which students engage in the various study activity levels will be presented. Second, data regarding the nature of the initiative to engage in each of the activity levels will be presented. Third, data regarding the kind of knowledge product students tend to focus on while studying will be presented. And finally, data regarding the kind of memory augmentation operations students engage in while studying will be presented.

Engagement in the hierarchical levels Students' pattern of responses regarding the strength of agreement to the four principal study activity levels is presented in Table 12 and Figure 4. In general, this pattern is in accord with the expectation of the hierarchical model. More specifically, students agree more strongly to performing lower-level activities than higher-level activities, and conversely, they disagree more strongly to performing the higher-level activities than to lower-level activities.

Insert Table 12, Figure 4

For example, at the Encoding level, 21% of the students responded with the strongest response alternative - "Very much like me," and 50% responded with the moderately strong alternative "Like me." Moreover, 25% responded with the marginal agreement alternative - "Somewhat like me," and only 3% indicated that Encoding is "Not at all like me."

The pattern of responses at the Selection level is similar to the pattern just described for the Encoding level, however, two small changes occur. First, there is a sight increase in the proportion of "Very much like me" responses at the Selection level (from 21% at the Encoding level to 28% at the Selection level). Second, at the Selection level, there is a slight decrease in the proportion of "Somewhat like me" responses (from 25% for Encoding to 21% for Selection) and "Not at all like me" responses (from 3% at Encoding to 1% at Selection). However, in general it should be noted that the vast majority of students indicated a moderate-to-strong endorsement of the Encoding and Selection activities.

For Integration level activities, the students' response pattern changes drastically. At this level, only 7% of the students endorsed the strongest response alternative "Very much like me" and 30% endorsed the moderately strong response alternative "Like me". However, 44% of the

students endorsed the marginal response alternative "Somewhat like me" and 19% of the students indicated that Integration activities are "Not at all like me".

The change in the pattern of responses noted for Integration level activities increases for Extension level activities. For example, only 6% of the students endorsed the strongest response alternative "Very much like me" and only 19% endorsed the moderately strong alternative "Like me." However, 35% of the students endorsed the marginal alternative "Somewhat like me", and a relatively large proportion of students (40%) indicated that Extension activities are "Not at all like me."

Initiative to Engage in Cognitive Processing Activities Students who positively endorsed either the Selection, Integration, or Extension activities were asked a specific follow-up question regarding what *prompted* them to engage in a specific study activity.

The results to the Initiative question for each activity level are presented in Table 13. The top of Table 13 gives the percent of student responses regarding what prompted them to engage in Selection activities. The majority of students (68%) indicated that they "used their own judgment in deciding to find the important material" (i.e., to engage in Selection activities). In addition, a little more than half of the students (51%) indicated that "Features of the material" prompted them to engage in Selection activities. The other response alternatives are, by comparison, less frequently endorsed. Thus, in general, students indicate that their decision to engage in Selection activities is to a large degree self-initiated. In addition, students indicate that Selection activities are prompted by stimulus features of the material, such as headings, outlines, or boldface print.

Insert Table 13

The middle of Table 13 gives the results regarding what prompted students to engage in Integration activities. Once again the pattern indicates that the majority of students (64%) endorsed the self-initiated response alternative, "I used my own judgment in deciding to relate ideas to other ideas in the reading." The other alternatives were less frequently endorsed. This pattern is similar to that found at the Selection level. However, one major difference occurs. The percentage of students who endorsed the first alternative, the Receptive or less self-initiated prompt, i.e., "Text or other material stated that I should relate information to other information," is considerably less at the Integration level (26%) than at the

Selection level (51%). This pattern of response suggests that Integration activities, compared to Selection activities, are prompted less by physical stimulus features such as text material. Moreover, the pattern of response at the Extension level is very similar to the pattern at the Integration level suggesting that students' initiative to engage in Extension activities is also self-initiated.

In general, the trend across the activity levels indicates that the majority of students report that they are self initiators of the various study activities. However, students also indicate that for Selection activities, explicit textual cues influence and prompt engagement in this activity.

Knowledge product focused on while performing study activities. The third dimension of the hierarchical model involves the type of information students concentrate on while studying.

Insert Table 14

For Encoding activities (shown in the top of Table 14), students indicated that while studying to get a basic understanding of the information they concentrated primarily on the "Meaning of words and concepts" (75%) and the "Meanings of sentences and paragraphs" (65%). In contrast, the alternative, "How words are pronounced," was relatively less frequently endorsed (8%).

The middle of Table 14 presents the results regarding the kind of knowledge product focused on while performing Selection activities. The results show that while engaging in Selection activities, a large proportion of students focus on "Main ideas and principles," (71%) "Definition and terms," 60%, and "Details and facts" 55%.

The bottom of Table 14 presents the results for Integration activities. As can be seen, 71% of the students report that they focus on "Main ideas and principles", 52% of the students report that they focus on "Details and facts", and 46% of the students report that they focus on "Definitions and terms."

In general, a large proportion of students report that they focus on all of the various types of knowledge products while studying (except for the Encoding alternative "How words are pronounced"). However, the results indicate that there is a slight trend for students to focus relatively

more on "Main ideas and principles" than on " Details and facts" or "Definitions and terms".

Memory Augmentation Students were also asked to indicate if they did anything special to help remember the material. Fifty-two percent (52%) of the students responded that they tried to do something special to make the information more memorable. These students were then asked to indicate *what kinds* of things they did while studying to help them remember. The results are presented in the top of Table 15.

Insert Table 15.

The response alternatives given in the top of Table 15 parallel the four study activity levels in the hierarchical model. The pattern of results revealed by the students' responses to these alternatives also followed the basic trend of responses found for the hierarchical study activity levels. For example, a large proportion of the students (53%) indicated that they "concentrated on remembering the basic meaning of the material"; a larger proportion of students, 68%, indicated that they "concentrated on remembering the important material"; a relatively smaller proportion of students, 36%, indicated that they "concentrated on remembering the relationships between ideas," and a relatively small proportion of students, 12%, indicated that they "concentrated on remembering how the information applies to things outside the course."

These same students were asked another follow-up question regarding *how* they tried to remember the information. Once again the response alternatives, as shown in the lower part of Table 15, were designed to form a graded response continuum beginning with relatively less generative and duplicative kinds of memory activities (e.g, "Repeated information word-for-word") to relatively more generative and constructive kinds of memory activities (e.g., "Made-up a chart, graph, or diagram").

The results show that 44% of the students indicated that they "Repeated words over and over" to help remember information, 61% of the students "Put the information in their own words" to help them remember, 15% of the students "Made up a story, rhyme or image to help them remember, and 15% of the students "Made a chart, graph, or diagram" to help them remember the material.

DISCUSSION

This paper has discussed the construction of a study activity questionnaire based on hierarchical models of studying and has presented some results regarding the characteristics of students' study activities in two study contexts: Routine studying and Test Preparation.

These results are mainly preliminary and descriptive and as such represent only a progress report of our current research program. More sophisticated analyses are currently underway. Specifically, we are using an Item Response Theory (IRT) model of measurement, called Partial Credit (Masters & Wilson, 1989), to analyze the data. These analyzes will more directly test our assumptions about the hierarchical model. However, from these preliminary findings several observations can be noted.

First, the data regarding students' engagement in the hierarchical study activities is encouraging. The pattern of responses to the activity levels is in accord with our model and lends support to the notion that the underling variable follows the predicted order and direction.

Second, the pattern of responses reported for the Routine context and the Test Preparation context are similar, however, small differences can be noted. These small differences may be important to the extent that students change the character of their study practices in response to specific contextual factors, goals, purposes, or demands. For example, while reading the assignment for the first time (i.e., Routine studying) students may concentrate to a large extent on Basic Encoding kinds of activities, i.e., getting an initial understanding of the material. However, at a latter time after they have gained an initial understanding, they may concentrate more heavily on trying to identify the most important portions of the material which might be on the test. That is, during the Test Preparation phase of studying, students may focus more on Selection activities. Thus, the character and nature of students' study activities may vary depending on the cumulative effects of prior study sessions as well as present context features. Viewed in this way the hierarchical model may reveal how a student's progression through a "cycle" of study activities in one context affects the nature of their study activities in different context.

Finally, it should be noted that the design of the SAQ, as well as the microcomputer-based administration procedure, appear to have a great deal of potential for assessment and diagnostics. As a way of increasing the precision and validity with which students' study behaviors are measured, the SAQ holds great promise.

References

Bransford, J.D., Stein, B.S., Shelton, T.S., & Owings, R.A. (1981). Cognition and adaptation: The importance of learning to learn. In K.H. Harvey (Ed.), Cognition, behavior, and the environment (pp. 93-110. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bransford, J.D., Sherwood, R., Vye. N., Reiser, J., (1986). Thinking teaching and problem solving:Research Foundations. American Psychologist, 41, 1078-1089.

Brown. A, L., Bransford, J. H., Ferrara, R. A. and Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell and E. M. Markman (Eds.), Handbook of child psychology (4th ed.). Cognitive development (Vol. 3, pp. 515-529). New York: Wiley.

Brown, A.L., Smiley, S.S. (1978). The development of strategies for studying texts. Child Development, 49, 1076-1088.

Franks, K., Vye, N. J., Auble, T.M., Mezynski, K.J., Perfetto, G.A., Bransford, J.D., Stein, B.S., & Littlefield, J. (1982). Learning from explicit versus implicit texts. Journal of Experimental Psychology, General, iii, 414-422.

Masters G.N. & Wilson, M. (1989).Understanding and Using Partial Credit Analysis: an IRT Method for Ordered Response Categories. Notes to accompany a mini training session given at the American Educational Research Association annual meeting, San Francisco.

Meyer, B. J. F., (1984). Text structure and text comprehension. In H. Mandl, N.L, Stein, & Trabasso (Eds.), Learning and comprehension of text. Hillsdale, NJ: Elbaum.

Mayer, R.E. (1987). Instructional variables that influence cognitive processes during reading. In B. Britton & S. Glynn (Eds.), Executive control processes in reading. Hillsdale, NJ: Lawrence Elbaum Associates.

Rohwer, W. D., Jr., and Thomas, J.W. (1987). The role of mnemonic strategies in study effectiveness. In M. A. McDaniel & M. Pressley (Eds.), Imaginal and Mnemonic Processes. New York: Springer-Verlag.

Thomas, J. W., & Rohwer, W. D., Jr. (1987). Grade-level and course-specific differences in academic studying: Summary. Contemporary Educational Psychology, 12 381-385.

Thomas, Rohwer, & Wilson (1989). Hierarchical Models of Studying. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Table 1. Amount of time engaged in Routine Studying.

Number of *days a week* students typically spent studying for biology outside of class.

Days per week	None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
% of students	1%	6%	12%	32%	20%	16%	7%	6%

Mode = 3 days per week

Number of *hours a day* students typically spent studying for biology outside of class.

Hours per day	None	.5 hr	1 hr	1.5 hr	2 hr	2.5 hr	3.0 hr	4.0 hr
% of students	0%	31%	32%	18%	6%	5%	0%	1%

Mode = 1 hour

N = 234

Table 2 Weekly allocation of total routine study time across 6 study activities. Routine Studying.

Study Activities	Number of students	Proportion	Mean amount of time	Total time per category	% of total time
1. Doing homework					
% of students	202	86%	40 min	135.5 hrs	50%
2. Reading					
% of students	108	46%	33 min	49.5 hrs	18%
3. Preparing study materials (notes, outlines charts)					
% of students	62	26%	34 min	34.5 hrs	13%
4. Reviewing the text book or study materials I made					
% of students	43	18%	34 min	24 hrs	9%
5. Reviewing teacher made handouts					
% of students	28	12%	31 min	14.5 hrs	5%
6. Testing myself					
% of students	23	10%	30 min	11.5 hrs	4%
				Total time	
				269.5 hrs	1.00
N = 234					

Table 3. Percentage of students engaging in various kinds of activities while doing the assigned reading. Routine Studying.

	Kinds of activities done while routinely reading the assignment.					
	Just read	Skimmed before reading	Took notes while reading	Highlight while reading	Skim instead of reading	Other
% agreed	51%	32%	30%	13%	5%	5%
N = 203						

Table 4 Proportion of student responses to the hierarchical study activities. Routine Studying.

	Basic Encoding	Selection	Integration	Extension
Not at all like me	.01	.03	.18	.32
Somewhat like me	.24	.30	.52	.42
Like me	.54	.46	.23	.16
Very much like me	.21	.21	.08	.10
Total No. responses	1.00	1.00	1.00	1.00

N = 203

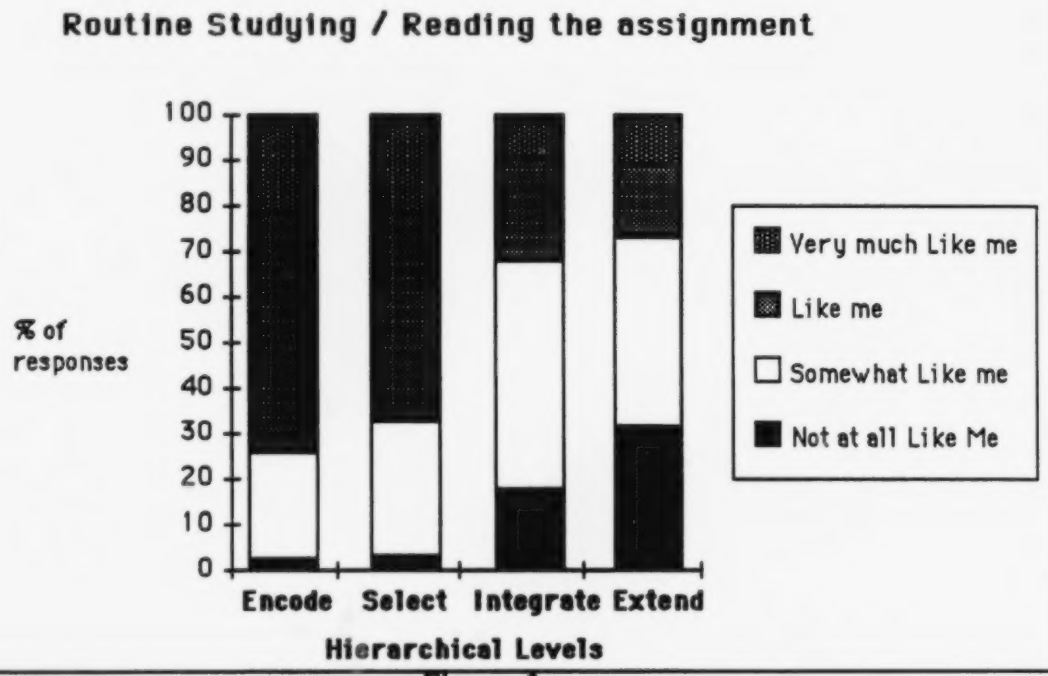


Figure 3
Percent of student responses to the hierarchical study activity levels.

Table 5 Level of processing activities during routine studying: A comparison of the two most negative and the two most positive alternatives. Routine Studying.

	Encoding	Selection	Integration	Extension
Not at all like me Somewhat like me	26%	32%	68%	73%
Like me Very much like me	74%	68%	32%	27%

Table 6 Sources of initiative for students' engaged in different levels of study activity . Routine Studying.

Percentage of student responses regarding what prompted them to engage in **Selection** activities

	Features of the mat	Teacher told us to find import	Teacher hinted that we should	Could tell from the text	Used own judgment	Other
% agreed	63%	16%	12%	12%	59%	6%

N = 199

Percentage of student responses regarding what prompted them to engage in **Integration** kinds of activities.

	Text, or other material stated to relate info	Teacher told us to relate information	Teacher hinted that we should relate information	Could tell from text to relate	Used own judgment	Other
% agreed	28%	13%	13%	15%	65%	5%

N = 171

Percentage of student responses regarding what prompted them to engage in **Extension** kinds of activities while reading the assigned reading.

	Text, or other material stated to apply info	Teacher told us to apply information	Teacher hinted that we should apply information	Could tell from text to apply	Used own judgment	Other
% agreed	25%	8%	18%	5%	74%	7%

N = 137

Table 7 The kind of knowledge product concentrated on while engaging in Encoding, Selection, or Integration activities. Routine Studying context.

Encoding

Percentage of student responses regarding the kind of information concentrated on while studying to get the **basic understanding** of the information.

	How words are pronounced	Meanings of words/concepts	Meanings of sentences/paragraphs	Other
% agreed	7%	64%	70%	5%

N = 194

Selection

Percentage of student responses regarding the kind of information concentrated on while studying to to **identify the important material.**

	Details/ facts	Definitions/ terms	Main ideas/ principles	Other
% agreed	59%	52%	75%	3%

N = 193

Integration

Percentage of student responses regarding the kinds of information concentrated on while engaging in **integration** activities.

	Details/ facts	Definitions/ terms	Main ideas/ principles	Other
% agreed	53%	41%	78%	4%

N = 168

Table 8. Memory augmentation activities students engage in to help remember information while studying.

Routine Studying context.

Focus of students' memory augmentation level by cognitive level of the study hierarchy.

	Concentrated on remembering the basic meaning	Concentrated on remembering the important material	Concentrated on remembering the relationships	Concentrated on remembering the how the info applies	Other
% agreed	49%	52%	33%	18%	15%

The percentage of students who indicated *how* they tried to remember the information.

	Repeated word-for-word	Put in own words	Made up chart, graph, diagram	Made up story/ rhyme/image	Other
% agreed	31%	66%	22%	17%	21%

N = 112

Table 9 Number of hours spent in test preparation in the week immediately prior to the test day.

Total number of hours per week

	None	.5 hrs	1 hr	1.5 hrs	2 hrs	2.5 hrs	3.0 hrs	3.5 hrs	4.0 hrs
% students	13%	11%	13%	15%	10%	6%	6%	7%	3%

	4.5 hrs	5.0 hrs	5.5 hrs	6-7 hrs	8-9 hrs	10-15 hrs	16-18 hrs
% students	4%	3%	2%	2%	3%	1%	2%

Mode = 1.5 hours per week

N = 232

Table 10 Allocation of total study time across 6 activities in the week immediately prior to the test day.

Study Activities	Number of students	% of students	Mean amount of time	Total hours	% of Time
1. Doing homework % of students	122	61%	56 min	116 hr	23%
2. Reading % of students	120	60%	51 min	103.5 hr	21%
3. Preparing study materials (notes, outlines,charts) % of students	90	45%	56 min	83.5 hr	17%
4. Reviewing teacher made handouts % of students	94	47%	42 min	65.5 hr	13%
5. Reviewing the text book or study materials I made. % of students	94	47%	48 min	77.5 hr	16%
6. Testing myself % of students	60	30%	45 min	44 hr	10%
				Total hours 490 hrs	
N = 200					

Table 11. The percentage of students who indicated that they made various kinds of study materials to help them prepare for the test.

	Study Notes	Lists of Information	Possible Test Questions	Out-lines	Sum-maries	Charts/ Graphs	Diagrams/ Tables	Flash cards	None
% Yes	78%	45%	32%	20%	16%	14%	13%	7%	10%

N = 210

The percentage of students who indicated that they used various kinds of material to review for the test.

	Reading lecture notes	Text/other reading	Homewk/ lab exercises	Study guides/ test prep handouts	Study materials I developed	Other
% Yes	71%	63%	63%	47%	23%	1%

N = 210

Table 12 Focus of students' study activities during autonomous test review by levels of the cognitive hierarchy.

	Encoding	Selection	Integration	Extension
Not at all like me	.03	.01	.19	.40
Somewhat like me	.25	.21	.44	.35
Like me	.50	.49	.30	.19
Very much like me	.21	.28	.07	.06
Total	1.00	1.00	1.00	1.00

N= 210

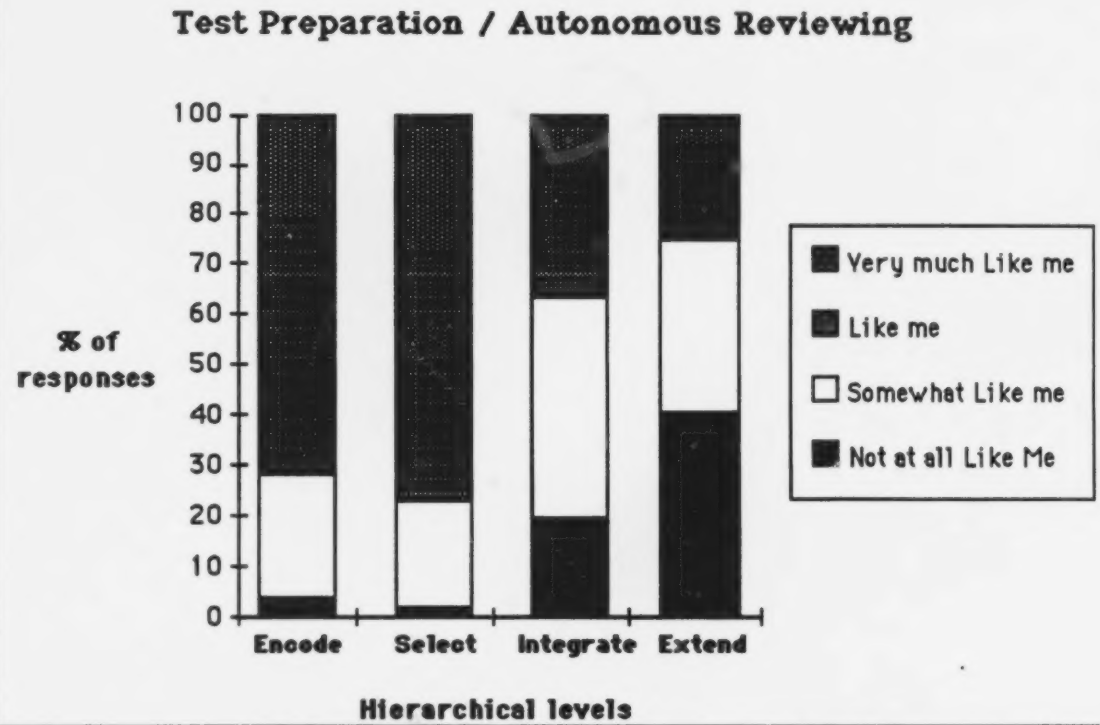


Figure 4. Percent of student responses to the hierarchical study activity levels.

Table 13 Percentage of students indicating what prompted them to engage in the different study activity levels. Test Preparation context.

Percentage of student responses regarding what prompted them engage in **Selection** activities

	Features of the mat	Teacher told us to find important material	Teacher hinted we should find import material	I Could tell from the text	Used own judgment	Other
% Yes	51%	14%	10%	20%	68%	1%

N =207

Percentage student responses regarding what prompted them to engage in **Integration** kinds of activities.

	Text, or other material stated to relate info	Teacher told us to relate information	Teacher hinted that we should relate information	Could tell from text to relate	Used own judgment	Other
% Yes	26%	14%	9%	18%	64%	2%

N = 170

Percentage of student responses regarding what prompted them to engage in **Extension** kinds of activities.

	Text, or other material stated to apply info	Teacher told us to apply information	Teacher hinted that we should apply information	Could tell from text to apply info	Used own judgment	Other
% Yes	29%	12%	12%	9%	63%	2%

N = 126

Table 14. The kind of knowledge product concentrated on while engaging in Encoding, Selection, or Integration activities. Test Preparation context.

Encoding

Percentage of student responses regarding the kind of information concentrated on while studying to get the **basic understanding** of the information.

	How words are pronounced	Meanings of words/concepts	Meanings of sentences/paragraphs	Other
% Yes	8%	75%	65%	3%

N = 189

Selection

Percentage of student responses regarding the kind of information concentrated on while studying to to **identify the important material**.

	Details/ facts	Definitions/ terms	Main ideas/ principles	Other
% Yes	55%	60%	71%	2%

N = 207

Integration

Percentage of student responses regarding the kinds of information concentrated on while engaging in **integration** kinds of activities.

	Details/ facts	Definitions/ terms	Main ideas/ principles	Other
% Yes	52%	46%	71%	2%

N = 170

Table 15 Memory augmentation activities students engage in to help remember information while studying.

Test Preparation context.

Focus of students' memory augmentation level by cognitive level of the study hierarchy.

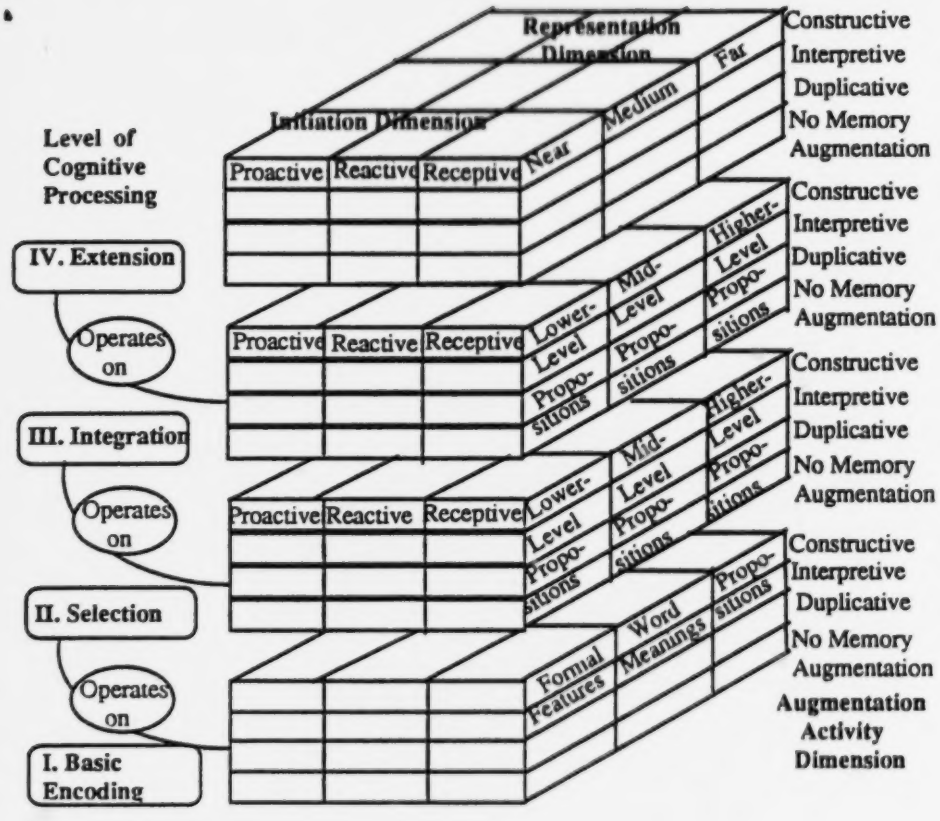
	Concentrated on remembering the basic meaning	Concentrated on remembering the important material	Concentrated on remembering relationships	Concentrated on remembering how the info applies	Other
% Yes	53%	68%	36%	12%	7%

N = 110

The percent of students who indicated *how* they tried to remember the information.

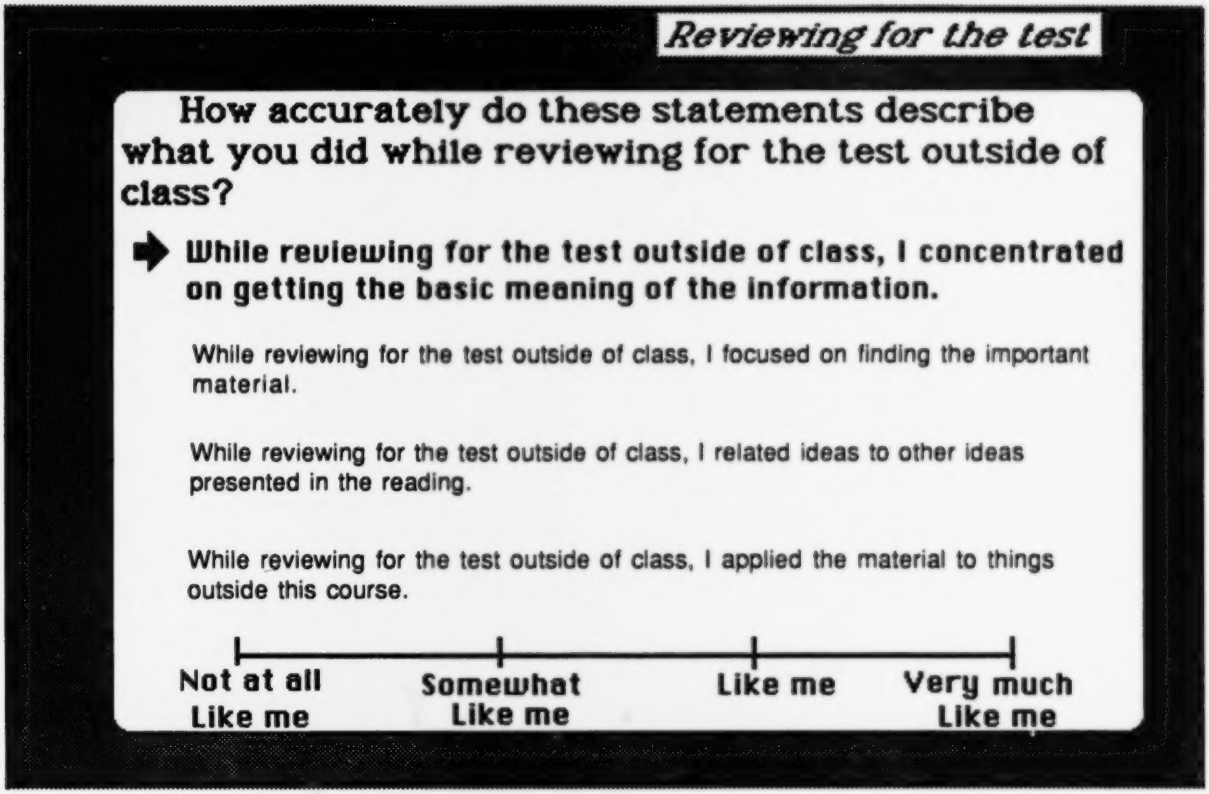
	Repeated info word-for-word	Put info in own words	Made up story/ rhyme/image	Made up chart, graph, diagram	Other
% Yes	44%	61%	15%	15%	13%

N = 110

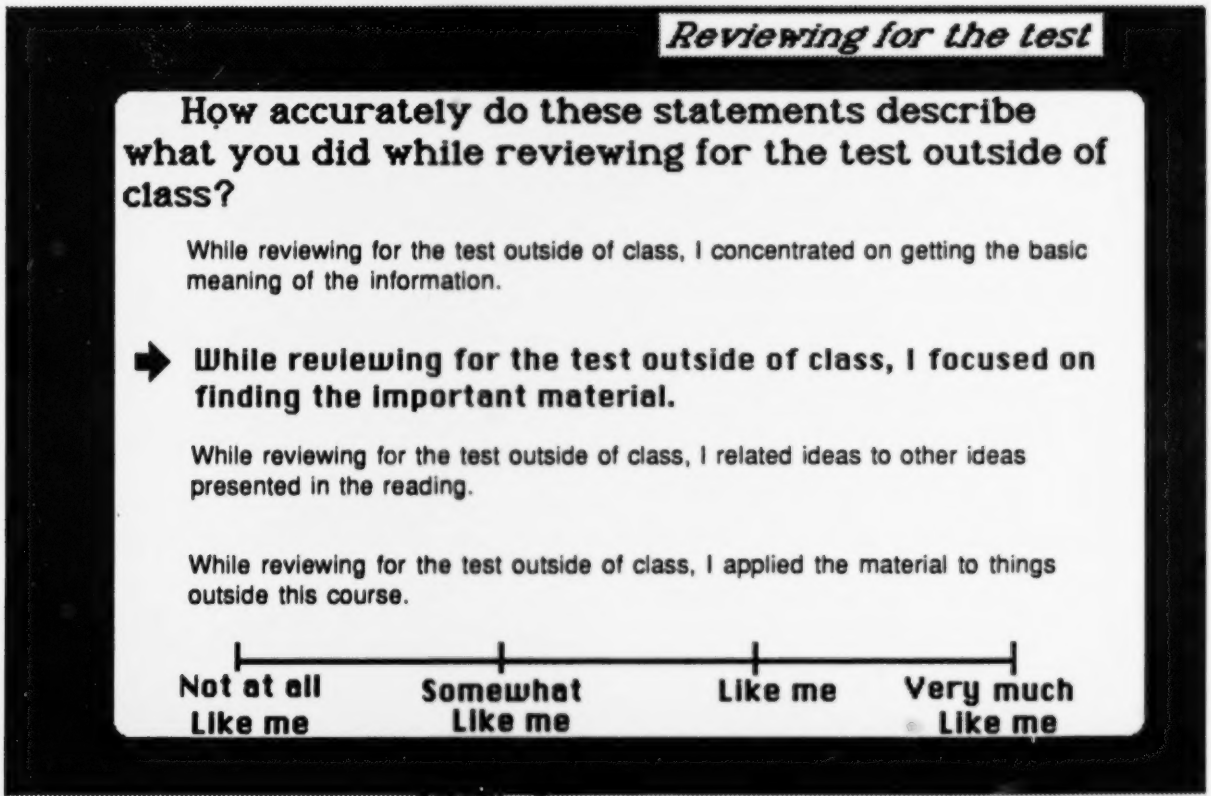


Hierarchy of Cognitive Study Activities

FIGURE 1


Reviewing for the test
How accurately do these statements describe what you did while reviewing for the test outside of class?
While reviewing for the test outside of class, I concentrated on getting the basic meaning of the information.
While reviewing for the test outside of class, I focused on finding the important material.
While reviewing for the test outside of class, I related ideas to other ideas presented in the reading.
While reviewing for the test outside of class, I applied the material to things outside this course.
Not at all Like me
Somewhat Like me
Like me
Very much Like me

SCREEN 1
FIGURE TWO.


Reviewing for the test
How accurately do these statements describe what you did while reviewing for the test outside of class?
While reviewing for the test outside of class, I concentrated on getting the basic meaning of the information.
While reviewing for the test outside of class, I focused on finding the important material.
While reviewing for the test outside of class, I related ideas to other ideas presented in the reading.
While reviewing for the test outside of class, I applied the material to things outside this course.
Not at all Like me
Somewhat Like me
Like me
Very much Like me

SCREEN 2
FIGURE TWO.

Reviewing for the test

You indicated that while reviewing for the test outside of class, you concentrated on finding the important material. What prompted you to find the important material?

- ☐ Features of the material like headings, outlines, lists, or boldface print.
- ☐ The teacher told us to concentrate on finding important material.
- ☐ The teacher hinted that we should find important material.
- ☐ I could tell from the text, handouts, or study guides that I should find the important material.
- ☐ I used my own judgment in deciding to find important material.
- ☐ Other _____(Fill in your alternative)

Next Question

SCREEN 3
FIGURE TWO.

Reviewing for the test

When you reviewed to find the important material, what kind of information did you concentrate on?

- ☐ Details or facts.
- ☐ Definitions or terms.
- ☐ Main ideas or principles.
- ☐ Other ____ (Fill in your alternative)

Next Question

SCREEN 4
FIGURE TWO.